An impact evaluation of technology adoption by smallholders in Sichuan, China: *The Case of Sweet Potato-Pig Systems*

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Introduction

- ✓ Sweet potato-pig systems is a major economic activity among millions of rural households in Sichuan, China; some 6.77 million households are in SP-pig systems, of which some 1.46 million are poor.
- ✓ SP-pig systems address one of the key constraints in smallholder pig production, i.e., seasonal crop shortages that result in fluctuating ability of feed supply to sustain the requirements of pig herd.
- ✓ Sweet potato is widely cultivated in Sichuan, especially in hilly or mountainous regions; about 4 million tons of roots are produced every year, of which about 70% is used as pig feed.
- ✓ Being an annual crop with vines and tubers easily perishable, the conservation of both parts is a technology option that can potentially extend the shelf life and availability of feed year-round.

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Sweet potato-based feed technology: CASREN project

- ✓ During the period 2001-2004, ILRI and CIP together with national partners from SASA implemented the CASRE Project, specifically developing and testing sweet potato-based feed technologies.
- ✓ New high-yielding sweet potato varieties produce more biomass, prompting the need for options to improve post-harvest crop storability.
- ✓ Ensiling of the roots and vines was tested and adapted by farmer collaborators; this technology helped extend shelf life and stabilized availability of SP-based feed supply.
- ✓ Noticeable impacts had been observed by the end of the CASREN Project, which prompted the need to properly document and evaluate these.

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Objectives of the study

- ✓ To evaluate the impact of adoption of sweet potato-based feed technology on pig production by smallholders in Sichuan.
- ✓ To identify critical factors that facilitate technology adoption by smallholders.

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Data sources and methodology

- ✓ Survey of households in CASREN project sites (exposed) and non-project sites (non-exposed)
  - ✓ 5 villages in Renhe Township (Aiguo, Baiguo, Guanlong, Tianle, Xinming); 111 households (exposed)
  - ✓ 1 village in Ziqiang Township (Ziqiang); 53 households (non-exposed)
- ✓ Sample respondents included a subset of households that were interviewed in baseline surveys at the start of the CASREN project.

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Analytical Framework

- ✓ Propensity score matching; this involves matching ‘participants’ with ‘non-participants’ using observable independent covariates.
- ✓ A discrete choice framework such as logit model can be applied to estimate propensity scores.
- ✓ Based on propensity score matching obtained from the logit estimates, the average treatment effect (ATT) can be computed, where ATT is the mean difference between the paired outcomes of ‘participants’ and ‘non-participants’ once pairs are identified.
- ✓ Matching algorithms commonly used are nearest neighbor matching (NNM), radius matching (RM), and kernel matching (KM).

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Empirical model of treatment effects

Model 1: comparing outcomes between adopters of silage technology and non-adopters of silage technology among users of SP-based feed technology (within SP adopters)

Dependent variable: Treatment dummy 1 =1 if adopter of silage technology, 0 if non-adopter of silage technology

Model 2: comparing outcomes between adopters of silage technology and non-adopters of SP-based feed technologies (between adopters and non-adopters)

Dependent variable: Treatment dummy 2 = 1 if adopter of silage technology, 0 if non-adopter of SP-based feed technology

The same set of covariates used in both Model 1 and Model 2: household demographics, non-pig production and other income, pig production characteristics, and exposure to silage technology.

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Adoption of silage technology: significant coefficients from logit estimates

Covariate	Odds ratio	Marginal effect
Model 1:		
Being located in exposed village (dummy)	2.1 (0.8)***	0.4 (0.1)***
Model 2:		
HH head having salaried employment	4.3 (1.6)***	0.7 (0.1)***
Proportion of triple cross breed pigs raised	0.04 (0.02)**	0.009 (0.004)
Used SP as feed prior to project (dummy)	1.9 (0.8)**	0.3 (0.1)***
Pig trader as main market outlet for pigs (dummy)	-2.3 (0.9)**	-0.5 (0.2)***
Used parasite control prior to project (dummy)	-2.4 (1.0)**	-0.5 (0.2)***
Being located in exposed village (dummy)	4.9 (1.5)***	0.6 (0.1)***

*** significant at 1% level, ** significant at 5% level, * significant at 10% level.

Treatment effects: estimates from matched propensity scores

Outcome	Matching method	# treated HHs	# control HHs matched	Ave. Outcome of treated	Ave. Outcome of control	ATT
Gross margin/kg	NNM	13	5	4.7 (2)	2.5 (1.6)	2.2 (1.2)**
	KM	13	19	4.7	2.6	2.1 (1.2)**
	RM	8	14	5.2 (1.7)	3.2 (2.5)	2.0 (0.9)**
Output (kg)	NNM	17	8	2068 (1379)	979 (394)	1092 (456)**
	KM	17	24	2068	1356	712 (498)*
	RM	10	24	1867 (1038)	1859 (1644)	8 (526)

*** significant at 1% level, ** significant at 5% level, * significant at 10% level.

Results suggest that silage technology adoption will likely generate at least an additional 2 Yuan gross margin/kg or at least 7 heads of pigs more per year.

Conclusions and implications

- ✓ Adoption of SP silage feed technology has potential to generate positive outcomes in terms of higher output and higher profits from pig production. Considering the likely recommendation domain of this technology in the context of Sichuan, technology adoption could have generated approximately 12.6 billion Yuan (or $1.8 billion) additional income to pig raising households in rural areas.
- ✓ SP-based feed technology is suitable in smallholder pig production; it also can potentially help pig raising households to transition from subsistence pig production to more market-oriented operation by enabling them to build assets in the course of productivity gains derived from being cost-efficient. This also promotes resilience, by having more options for coping with external shocks from markets, e.g., price volatility of inputs and outputs.
- ✓ A targeted approach to scaling up of this technology is warranted; labor intensive nature of the technology (for feed preparation) is a key constraint to adoption where availability of household labor in rural Sichuan is competing labor opportunities outside the farm.
- ✓ SP-based feed technology is suitable for scaling up in less intensive systems where SP is an important crop, in areas with poor access to markets for inputs and outputs, where SP and pigs are important contributors to HH income and livelihood, in rainfed upland areas, and in areas with relatively more land available for SP production.

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